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GEOPHYSICS.—*A theory of terrestrial volcanoes and the geography of the moon.*[1] STANISLAS MEUNIER, Museum of Natural History, Paris. (Communicated by Arthur L. Day.)

Long-continued studies have led me to develop a new theory in regard to the phenomenon of volcanoes, a theory which, it seems to me, harmonizes with the best-established facts of geodynamics, differing therein from all preceding theories. A necessary sequel has been a study of the consequences to which the theory leads as regards the future of eruptive activity itself.

In making that study, I adopted the method of the mathematician, who proceeds to the solution of a given problem by varying the elements of the problem in order to discover the corresponding special cases. Accordingly I have assumed hypotheses regarding the geologic consequences that result from modifying the variables of the problem. I shall not try to conceal the satisfaction I felt on finding that one of the suppositions examined explains completely the circumstances of lunar economy.

The discussion involves three main consequences:

1. It tightens in an unexpected manner the geologic bonds existing between the earth and the moon. This result is so conformable to the ingenious cosmologic conception of Laplace as to constitute a veritable confirmation of it, by furnishing definitive proof of the similarity of the physical constitution of our

[1] Translated from the French.

globe and its satellite, as well as of the identity of their behavior in the course of sidereal evolution, in which they represent two successive stages.

2. In the second place, the relation of the history of the moon to the history of the earth, so different at first sight as regards the phenomena of volcanism, includes the verification, the tangible verification so to speak, of the eruptive theory, although the latter had been established on purely geologic considerations at the very moment when I felt compelled to postpone the selenographic study, which seemed to require a combination of special conditions.

3. Finally, by means of a correlation which *a priori* seemed hazardous, my results furnish a new support for that great chapter of science which is yet far from being fully understood, but which nevertheless has so often and so strongly fascinated me from the very beginning of my career, namely, the chapter of comparative geology.

This may seem a bold program, and in laying it before the reader I feel that it may arouse a certain skepticism. Nevertheless I feel confident that my undertaking will benefit the work on which I am engaged, namely, the building-up of a body of arguments which will naturally group themselves into one of the chapters of the geologic harmonies of the physical universe.

In order readily to understand the bearing of the statements just made, it is necessary to call briefly to mind the nature of the proposed volcanic theory and what, in my opinion, it is capable of explaining.

According to this theory, *volcanic activity* is a normal and therefore inevitable result of the regular evolution of our globe. It therefore determines, on the one hand, all the details of the earth's constitution, that is to say, of its *anatomy*, and, on the other, all the details of its activity, that is to say, of its *physiology*. According to this theory, also, volcanic activity is a natural and frequent result of the formation of mountains, being in fact its epiphenomenon, so to speak.

We have to recall the circumstances accompanying the be-

ginning of planetary history and to assume, with Laplace, that the earth is but a drop of the chaotic substance separated from the sun, like the other globules of the same nature, which, before or after it, have taken on the condition of autonomous bodies. The sun represents the enormous residue of primordial matter from which these successive products were derived.

The globular form assumed by the mass that was to be our planet results from the dominant property possessed by the molecules of all mobile matter to attract one another and thus to become grouped around their common center of gravity. Laplace has shown how this attraction causes the heating of the whole mass and at the same time its general movement of rotation around its own axis. We need add nothing to the conception of the author of the *Exposition du Système du Monde* in order to understand in outline the successive stages of our globe, all due to the spontaneous cooling caused by its position in space, the temperature of which is far below that of the earth itself.

The first effect of cooling was to deprive the chaotic matter of any homogeneity which it might have had at the start, the result being a solid crust forming a partition between the uncooled fluids that constitute the nucleus of the globe and the far less dense fluids forming the ocean and the atmosphere.

Ever since the crust began to form and to grow thicker by additions on the inside, owing to the progressive solidification of the nucleus, it has tended to accommodate itself to the ever-changing conditions arising from the steady diminution in volume of the enclosed mass. While that mass contracts during cooling without changing its form, which remains spherical while its diameter decreases, the crust, which is not contractile, responds in a different way. As the support furnished by the fluid nucleus is withdrawn because of its contraction, the crust has to follow it and hence becomes increasingly corrugated, with attendant faults (geoclases) and tangential thrusts.

This is the well-known cause of topographic relief, the cause of continents and oceanic basins. The water, instead of covering the globe as a uniform sheet, has collected in the oceanic

basins, to which, by a ceaseless circulation, it always returns after falling as rain and flowing over the land as storm water and running water—aside from the large amount that seeps into the ground, of which we will speak later on.

Without entering into details which every one knows, I will merely add, for the sake of clearness, that the deformations of the earth's crust, constantly diminishing the diameter of the planet, consist essentially in the transformation of a centripetal action into a tangential compression, as is shown by the great mountain ranges, whose natural escarpments so often and so clearly reveal to us the internal structure. In these mountain ranges beds of a great variety of rocks are seen resting one on the other, which may be correlated with the strata of the plains, but which have been modified in their mineral composition by metamorphism and in their relative position by orogenic forces.

As regards the last-mentioned point, the essential fact is that geologically old strata commonly rest on geologically younger strata, which is exactly the reverse of what prevails in undisturbed sedimentary regions. When, for example, we climb the Alps we first pass over very recent beds, such as the Tertiary conglomerates of the Righi, next over Mesozoic deposits, such as the Cretaceous and Jurassic marbles of Mount Pilatus, next over Paleozoic sediments, such as the Carboniferous shales of the Mœde, etc., and only when we arrive at the top do we find the primitive rocks, such as the gneisses of the Jungfrau.

There can be no doubt that these strata were pushed along nearly horizontal planes of fracture, with the result that they now occupy a much smaller area than they did originally, while their thickness has increased by superposition, as has just been pointed out. Thus there has been a transfer of deep-seated material over younger strata. It is necessary to recall this commonplace notion, because it suffices to give us the viewpoint needed for the present subject as regards everything relating to the structure of mountain ranges, which for that matter varies widely.

Summarizing this first point, we see that the spontaneous cooling of the globe gives rise to a tangential compression of the

crust, which at any given moment is too wide for its contents, and that this is the sole cause of the characteristic superpositions observed in mountains.

This, however, does not yet suffice to explain completely the origin of mountains, and it is proper to note that the process just described is strictly confined to the underground regions. In order that a mountain may be formed another thing is necessary; the block that has been compressed in the underground region has to be raised by tangential reactions, causing a protuberance that rises above the general surface of the planet. The gigantic tuberosity of Thibet, in the heart of the Asiatic continent, is a type.

Space will not admit of presenting the arguments which prove that the compression and transfer on the incline planes of geoclases can take place only in a certain portion of the crust. The deeper portions are still too hot to admit of the production and maintenance of gliding planes in their plastic substance, while in the outer parts the porosity and compressibility of the rocks constituting the substratum, opposing their inertia to the propagation of vibrations, protect the superficial strata against excessive mechanical shocks, which would constitute an insuperable obstacle to the development of external phenomena, such as the manifestations of organic life.

Without dwelling on this subject let us note merely that the mechanical deformations of the crust are not the only inevitable consequences of the spontaneous cooling of the globe.

Another fact of equal importance, and without which volcanism would be impossible, develops parallel with the first. We have already noted that the lowering of the surface temperature has led to the condensation of water, the fall of rain, and the development of rivers, whose waters accumulate in the ocean basins. Part of the water penetrates into the crust not only by constant infiltration but by the burial of wet sediments under later sediments, whereby water and other volatilizable matter are imprisoned in the solid mass at constantly increasing depths and are incorporated in a large part of the thickness of the crust.

This being premised, we must next observe that the over-

thrusting just described, whereby the rock masses are superposed (often in inverted order) acquires a new meaning from the very presence of water. The water-soaked zone thus forms an envelope around the deeper zone which is as yet too hot to admit the entrance of water. At many points the orogenic compression, taking advantage of geoclases, carries hot waterless strata over less hot water-soaked strata. The latter are thus subjected to *reheating* under circumstances which are particularly interesting. We know the effects that are likely to be produced by such reheating under the influence of water incorporated in deeply buried rock masses having no communication with the surface. On this point Sénarmont has made experiments of which I am unable for lack of space to mention more than the results. He has shown that in *superheated* water, as he called it, that is to say, water subjected to a temperature of several hundred degrees in a closed vessel, the ordinary rocks take on all the characters of metamorphic and volcanic rocks. The water, strongly compressed and having reached the condition when it assumes the mineralizing function, becomes incorporated with the rock particles, and thus in the state of occlusion it endows them with the expansive property.

Suppose next that a mass of rocks thus charged with occluded water under high pressure is put into communication with the atmosphere through a fissure, for example. The occluded vapor, no longer held back by a resistance equal to its expansive force, will seek to attain equilibrium of pressure with the atmosphere; it will issue from its confinement and carry with it the rock magma in which it is dissolved, ejecting it through the vent, and thus will produce the volcanic phenomenon in all its details. Without attempting any detailed proof, let us note that this line of reasoning explains all the incidents of the volcanic phenomenon, from the ejection of ashes, vesicular pumice, and scoriae to the rise and overflow of lava and even the formation and reaction of fumaroles.

Volcanism as a whole, as has just been found to be the case with seismism, is an epiphenomenon of the production of mountains. This is why intrusions of igneous rocks in all their forms play such a prominent part in all complete mountain ranges.

Summarizing, we may say that eruption results from the collaboration of two processes, seemingly quite unrelated:

1. The *progressive penetration of water* and other volatile substances to a depth within the earth's crust which is strictly dependent at every instant on the degree of spontaneous cooling;

2. The *tangential compression of the rocks*, due to the contraction of the nucleus and also to the tendency of the crust to founder into deeper and deeper regions where the horizontal space grows narrower and narrower.

Thus the crust of our planet forms a kind of weaver's loom, producing the volcanic tissue, the *warp* being represented by the descending network of threads of water, while the *woof* is represented by the tangential network of heated material, due to the orogenic superposition of intrusive masses over water-soaked sediments.

Harking back to the point from which we started, we may here adopt the practice of the mathematician who devotes himself to the discussion of a given problem. We may inquire what special results would follow from modifying one or the other of the two factors of the eruptive phenomenon.

Let us note, first of all, that the volcanic phenomenon could only have appeared after a long evolution of the terrestrial globe, because it requires a crust, and not only this but the superposition of two concentric zones: the one deep down and very hot, the other at less depth, impregnated with water and of moderate temperature.

However, to dwell on this point would be to enter into the domain of comparative geology. Suffice it to say that from the moment when the crust was formed, and long before, eruptions had taken place, different no doubt from, but yet comparable in certain respects and belonging to, the class now represented by the majestic spectacle of the solar eruptions.

Hervé Faye recently established the synthetic theory of the sunspots and of the red protuberances accompanying them, and showed that these phenomena represent an incessant radial circulation of the material constituting the epidermic zone of the sun; we might almost say the *cortical* zone, for the photosphere

represents as it were a rudimentary crust, situated, like the earth's crust, between the atmosphere and the nucleus, but as yet in an unstable condition because of its extreme thinness. It exhibits one of the stages through which the lithosphere of our own globe must necessarily have passed.

The circulation, which (like the circulation of water in the earth's organism) is radial, results from conditions no longer found on our globe, conditions due to the extreme mobility of all the solar elements. Faye notes the production of whirlwinds in the sidereal mass, and he does not hesitate to compare their course and cause to those of the eddies in rapid rivers. The solar eddies, like those of rivers, carry into the depths of the moving fluid the material derived from the peripheral zone, and their descent, though effected in quite a different way, reminds us of the progressive soaking of the rocks by water, for, like this soaking, it results in producing the mechanical force that is the cause of eruption. Once this relatively cool material derived from the solar surface has been carried to the proper depth, it is heated, expands, and yields to an enormous pressure tending to shoot it out into the atmosphere, where it forms the rose-colored flames. Evidently it cannot burst forth in this way without carrying with it material derived from relatively lesser depths, especially from the photosphere. This process shows that the solar explosion is an agent for the mixing of substances which by the diversity of their physical properties seemed destined to be forever separated, just as happens in the case of volcanic eruptions on the earth.

We are not yet in a position to give an exact account of the details exhibited by the volcanic phenomenon at its first appearance, as soon as the necessary conditions were realized on our globe. However, observations of a purely geologic nature show that the upheavals of rocks since the oldest sedimentary epochs are so closely comparable to the work of modern eruptions as to suggest that the appearance of volcanoes was virtually instantaneous. To gain a clearer view on this point we should have to consider successively the consequences that would flow from the various possible combinations of temperature distri-

bution along one and the same terrestrial radius, under the complications that would arise from the fact of the freezing of water at the surface and also at greater and greater depths. We should also have to make the same inquiry as regards the distribution of the water soaking into the deep strata, which would necessarily carry with it the zone of volcanic activity. All these subjects, and various other subjects besides, suggest discussions, some of which promise definite conclusions. It may suffice here to suggest them, while awaiting fuller data from the progress of science. We can merely attempt to set up a few hypotheses as regards the future of eruptive activity.

First of all, we may turn our attention to the relations between the cooling process and the stock of infiltrated water. The quantity of water available in the superficial regions of the earth is evidently limited, and the progress of cooling constantly tends to diminish the amount of water in seas, lakes, air, and even in the interstices of rocks. The tentative estimates made on this point at various times, by totally different methods, have invariably led to the conclusion that the quantity of water already absorbed by the crust is several times larger than the total volume of water still remaining on the surface in the liquid state; and that this remainder is only a small fraction of the amount that would be needed to saturate the entire crust to the degree of humidity observed in moist rocks, described by the expressive term of *quarry-water*. A time will come, therefore, when the earth will be completely dried up, because all its water will have disappeared, by infiltration, in the beds of rock.

On the other hand the globe, growing cooler all the time, will some day arrive at a state of equilibrium with the temperature of space. Thus the two factors of volcanism will disappear independently of each other, and not necessarily at one and the same time.

Several suppositions may be based on this consideration. Suppose, first of all, that the time necessary for the complete absorption of the water by the crust is exactly equal to the time required for the complete cooling of the globe. In that case it may be that the volcanic phenomenon may gradually fade away

and disappear without any important modification of the exterior of the planet.

Suppose, in the second place, that the quantity of water were much larger than it actually is on the earth. In that case, when the cooling has been completed, the whole planet will still be impregnated with water, a surplus of which will even remain on the surface. Long before that time, of course, the water will be frozen, and ice will be a rock like the other petrographic species.

Let us, however, take the opposite case, supposing that the quantity of water is insufficient to moisten the entire rock mass during the process of cooling. In that case the volume of the seas and of all the other liquid water bodies of the surface will diminish until it disappears, and the globe will be completely dried up while still warm. But—and this is the essential point—the drying up will not necessarily cause the disappearance of the volcanic phenomenon. That phenomenon is not a superficial reaction; on the contrary, its focus is situated at a great depth, and that depth is consantly increasing as the absorption of liquid water continues. Thus the conditions necessary for an eruption may continue long after the drying of the surface is completed. For example, the water that active volcanoes emit nowadays no doubt represents a contribution from the ocean going back to very ancient geologic periods. The orogenic superposition of moist subterranean regions by hot rocks driven tangentially over the roof of the great geoclases may continue for long geologic periods, which means that water of impregnation will continue to be occluded in the substance of ancient sediments, which will take advantage of the smallest fissure communicating with the upper, less dense regions to inject themselves into them by expansion. The feebleness of the atmospheric pressure, dwindling little by little to zero, will increase the number and energy, perhaps also the volume, of the outbursts, and will especially affect the *relief* of the material ejected upon the surface as cones of lapilli and ashes, needles, chaotic accumulations of scoriae, and lava flows. In addition the superficial water, except the volcanic rains, having little by little

disappeared, erosion, formerly so active, will cease, and consequently the products of eruption will persist without much alteration. Meantime the centers of eruption will constantly increase in number, until they may eventually cover the entire surface of the planet. By a singular contrast the planet destined to perish by progressive cooling will don as its final garment a shroud woven by volcanic energy.

The picture thus drawn of the effects of a prolongation of volcanic activity after the complete absorption of the surface water is closely analogous to the most essential features of lunar geography. Without going into detail, I will content myself with expressing my satisfaction on finding that the volcanic theory outlined at the beginning of this article is completely borne out by an object-lesson, the moon.

Let us suppose that this theory really expresses the facts, and that the earth at the dawn of the Tertiary epoch had reached a condition where all its surface water had been absorbed, while the volcanic activity was still in full blast. It is easy to see what would have happened. Volcanic eruptions would have continued, and their products would have been spread over the surface; but there would have been this essential difference, the volcanic outflows would no longer have been exposed to the destructive action of rain and seas. They would have accumulated side by side without perceptible change. To form an idea of the morphologic effect on the earth's surface it may suffice to point out that the previous sediments would have disappeared, more or less completely, beneath this sheet of volcanic material.

The importance of this fact will be appreciated if we cast a glimpse at the condition in which Europe, for example, would be if all the eruptive formations poured out since the beginning of Tertiary time had remained intact, side by side.

From Iceland, with Hecla and its companions, from the British isles, with Skye, the Hebrides, the Faroes, and Ireland, with Antrim, to the Mediterranean basin, with Sicily, continental Italy, Elba, and Santorin, the Tertiary and Quaternary eruptive centers follow one another without any wide gaps. All central Europe was volcanic: Hungary and Transylvania are

dappled with trachytes and rhyolites; Bohemia rests on vast and highly varied outflows; in the Höhgau, basalts are associated with phonolites; the Siebengebirge around Bonn, the Drachenfels, Mount Meissner in Hesse, the so-called Kaiserstuhl region in the Breisgau, the vicinity of Mainz and of Cassel, the Eifel, and above all the vicinity of the Laacher See, are made up of outflows, and their analogues occur throughout the central plateau of France, in Puy-de-Dôme, Mont-Dore, Cantal, Velay and Vivarais, and also in Catalonia, near Olot and Castel-Follit. The Carpathians, the Caucasus, the region of the Great Ararat, and Allagöz belong to the list, which we may here bring to a close, long before it is complete.

If we remember that the other parts of the world are not less rich in volcanic manifestations than Europe, and if we recall that the ocean basins also are dotted with them—the Indian Ocean as well as the Pacific and Altantic showing everywhere eruptive centers, most of them as yet imperfectly known; if, finally, we remember that in the absence of rain and wind the pulverulent ejections of the volcanoes would cover the earth's surface around every fiery vent in such a way as to mask all the anterior formations under this volcanic snow, we shall arrive at the conclusion that the earth would exhibit all the characteristics shown so clearly and sharply on the disk of the moon. So far as I am aware, this is the first time, since observers have been busy with the lunar problem, that its explanation crops out of itself as a logical consequence of a hypothesis elaborated independently of any astronomic considerations.

In conclusion I may be allowed to dwell on the last remark, which suggests a reflection in the line of comparative geology: That science has grown up on the common frontier of geology (or science of the earth) and physical astronomy (or science of the heavens), exactly as comparative anatomy has grown up on the common frontier of human anatomy (or science of the human body) and animal anatomy (or science of the bodies of animals). The resemblance extends even to the increase of knowledge and to the philosophic generalizations by which both of the compared sciences benefit. The great general laws of animal organ-

ization, revealed to us by the science of comparative anatomy, are an earnest of those which we may discover in regard to the economy of the celestial bodies as a result of the progress of comparative geology. We know that astronomy proceeds not only by purely morphologic investigations of the celestial bodies, but that several other means of study have been opened to it successively by physics and chemistry; spectroscopy, which is based on the prismatic analysis of the light emanating from the heavenly bodies or reflected by them, has demonstrated the chemical unity of the heavens, just as telescopy had shown their mechanical coordination. On the other hand, through a piece of good luck which no one could have foreseen or hoped for, bits of substance derived from the cosmic regions and precipitated on our planet in the form of meteorites, have supplemented the spectroscopic evidence by a large number of extraterrestrial minerals, enabling still closer comparisons to be made. A geologic relationship has thus been revealed, and the legitimacy of synthetic suppositions of the widest scope can now no longer be called in question. It does seem as if we were now in position to say that all conceptions that hold that the physical constitution of heavenly bodies differs from the constitution of the earth are erroneous. I may be permitted to express the hope that the present paper may serve to reinforce this conclusion by showing that the moon, which has inspired so many hypotheses, in reality presents morphologic features that are not only compatible with those of the earth but also harmonize completely with the proposed volcanologic theory of the earth, an agreement as neat as it was unforeseen. It furnishes the most valuable confirmation of that theory, while in return it receives not less decisive confirmation from geologic studies.

It is a rare pleasure to find such complete agreement between two lines of study which at first sight seem so unrelated. I may even be permitted to express a sort of gratitude, somewhat superstitious perhaps, to the Unknown Cause which reveals to our minds some of the harmonies, hitherto so jealously hidden, of the natural mechanism. A glimpse of these harmonies sometimes bursts on the mind so suddenly that one has the feeling of an astonished spectator rather than of an originator.

PHYSICAL CHEMISTRY.—*Thermoelectric measurement of the critical ranges of pure iron.*[1] GEORGE K. BURGESS and H. SCOTT, Bureau of Standards.

The methods hitherto employed for the determination of the thermoelectric properties of conducting materials possess the characteristic, which is particularly disadvantageous in the case of a substance such as iron which has two critical ranges, of

TABLE 1

THERMOELECTRIC POWER OF IRON AGAINST PLATINUM

TEMPERATURE CENTIGRADE t	MICROVOLTS PER DEGREE dE/dt		PELTIER EFFECT TdE/dt		THOMSON EFFECT d^2E/dt^2	
0	19.5		5,320		−0.010	
100	18.1		6,750		−0.027	
200	15.4		7,280		−0.035	
300	11.7		6,700		−0.033	
400	9.5		6,390		−0.010	
500	9.1		7,030		+0.009	
600	10.8		9,430		+0.026	
700	14.3		13,910		+0.036	
780	18.1		18,980		+0.045	
800	18.4		19,740		+0.014	
880	19.4		22,350		+0.010	
	Heating	Cooling	Heating	Cooling	Heating	Cooling
900	19.7	17.5	23,100	20,510	0.000	−0.400
910	19.4	10.8	22,940	12,770	−0.050	−0.040
920	16.6	10.9	19,800	13,000	−0.575	+0.010
930	11.4	11.1	13,710	13,350	−0.023	+0.017
1,000	12.6		16,030		+0.017	

requiring a length of the material in question to have a temperature distribution extending from the maximum to the lowest temperature. There may then be ambiguity or superposition of thermoelectric effects.

Using a length of pure iron wire (Fe = 99.968 per cent) of some 7 cm. length and 0.05 cm. diameter and joined between the hot

[1] To appear in detail as Bureau of Standards Scientific Paper No. 296 (Bull. Bur. Stds., vol. 14).

junctions of two Le Chatelier thermocouples within a furnace 60 cm. long, several series of accurate observations in vacuo of the thermoelectric power of the couple iron-platinum have been taken, at 2° intervals, over the temperature range 0° to 1000°C.

In the thermoelectric power vs. temperature curve the critical point A_3 is marked by a discontinuity of considerable magnitude at about 915°C. on heating, and at 900°C. on cooling. At A_2 there is a change in shape of the curve. The thermal effect at A_2 is superimposed upon the thermoelectric and manifests itself as a slight protuberance or dent at 768°C.

In Table 1 are given the thermoelectric power (dE/dt), Peltier effect (TdE/dt), and Thomson Effect (d^2E/dt^2) for iron-platinum from 0° to 1000°C.

These thermoelectric observations give further evidence of the distinct character of the critical points A_2 and A_3 delimiting the regions of alpha, beta, and gamma iron.

BOTANY.—Severinia buxifolia, *a Citrus relative native to southern China.* WALTER T. SWINGLE, Bureau of Plant Industry.

In southern China, Tonkin, and Annam, and in the adjacent islands of Formosa, Hongkong, and Hainan, there occurs not uncommonly a much-branched thorny shrub which has shiny box-like leaves and small, black, berry-like fruits, 1–1.5 cm. in diameter. This plant is commonly called *Atalantia bilocularis* (Roxb.) Wall., or *Atalantia buxifolia* (Benth.) Oliv. in recent botanical works. In connection with a survey of the plants related to *Citrus* this plant has been studied, with the result that it seems necessary to recognize it as constituting the type of a distinct genus, for which, fortunately, there is a valid name, *Severinia*, established in 1840 by Tenore.

The nomenclatorial history of this plant has been a checkered one. The earliest reference to it by a European botanist seems to have been in 1757, when Osbeck, one of Linnaeus's pupils, published the original Swedish edition of his diary of a voyage to the East Indies. On October 20, 1751, he found on Danish Island, near Canton, China, a plant of which he says "*Buxoides aculeata*, what the Chinese call *Sau-pann-gipp*, is like our box-

tree, but thorny. I did not see its parts of fructification."[1] Although a Latin binomial name is apparently assigned to this plant, it is very unlikely that it was intended as a true botanical name, inasmuch as Osbeck's teacher, Linnaeus, strongly objected to generic names ending with *-oides*.[2] At any rate the description is insufficient to identify the plant, of which Osbeck did not see the flowers or fruits. So far, the Cantonese name *Sau-pann-gipp* cannot be traced, but Loureiro gives for his *Limonia monophylla* a similar Cantonese name, *Sǎo peng lâc*,[3] "lâc" being perhaps the common Cantonese word *lak*, meaning thorn.

In 1798 Poiret described in the *Encyclopédie méthodique* of Lamarck, as *Citrus buxifolia*, a plant which had been found in China by Sonnerat. The latter had forwarded specimens of it to Citizen Lamarck, in whose herbarium Poiret had examined them.

Already in 1790 Loureiro in his *Flora Cochinchinensis* had described this same plant, but had referred it erroneously to *Limonia monophylla* L.

In 1825 David Don in his Flora of Nepaul described, as a new species, *Limonia retusa*. Although the description is very short and the writer has had no opportunity of examining Don's specimens, it seems very probable that Don's diagnosis refers to the plant in question.

Another obscure name, *Limonia microphylla*, published in 1828 by Voigt, would seem to belong here. Voigt's article is a description of the plants cultivated in the Jena Botanic Garden and the descriptive phrase following the name reads merely "folia Buxi apice emarginata, crenata." This phrase, however, seems to warrant considering Voigt's plant identical with the one in question.

[1] *Buxoides aculeata*. Obs. kallas på Chinesiska Sau-pann-gipp; och liknar wår Buxbom; men är taggig. Fructificationen blef jag aldrig warse.—Osbeck, Pehr. Dagbok öfwer en Ostindisk Resa, p. 242. Stockholm, 1757.

[2] "Nomina generica in *oides* desinentia, e foro Botanico releganda sunt." Linnaeus, C. Philosophia Botanica, §226. 1751.

[3] Loureiro, J. Flora Cochinchinensis, 1: 271. 1790.

Desfontaines, in the third edition (1829) of the catalogue of plants of the Paris Botanic Garden, describes as a new species *Citrus emarginata*, which is undoubtedly the same plant.

While Don seems to have been the first to record this species from India, Wallich and Roxburgh again report it from that country (1832), but under a different name. This time it figures as *Limonia bilocularis* Roxb. or *Atalantia? bilocularis* Wall.

In 1834 Wight and Arnott described this species as *Sclerostylis atalantioides*, referring to it as synonyms *Atalantia? bilocularis* Wall. and *Limonia bilocularis* Roxb. These authors add that no one except Dr. Berry, who had sent it to the Botanic Garden in 1807, seemed to have found this plant in India.

The first botanist to recognize this plant as belonging to a distinct genus was Tenore, who in 1840 published a new genus *Severinia*, transferring to it *Citrus buxifolia* of the gardeners as *Severinia buxifolia*. Tenore seems to have overlooked the fact that *Citrus buxifolia* was no mere gardener's name, but had been properly published by Poiret in 1798. In the following year Tenore submitted this and two other of his new genera to the Third Convention of the Italian Scientists held at Florence in September, 1841, for their approval. The President of the Section, Professor Moris, appointed three distinguished foreign botanists—Robert Brown, Heinrich Link and Charles Morren—present at the meetings, on a committee to report on the matter. Robert Brown, chairman, reported a few days later that *Severinia* seemed to the committee to be a good new genus of the orange family.[4]

However, George Bentham, in 1851, took exception to Tenore's new genus, stating that specimens sent him by the latter had enabled him to identify this as "a not uncommon Chinese plant," and transferring Tenore's species to *Sclerostylis* as *Sclerostylis buxifolia* Benth. Ten years later Bentham in-

[4] "Che la *Severinia*, pianta della famiglia delle Auranziacee sembragli ancor essa poter con buona ragione formare un genere nuovo. Per i suoi caratteri somigliare essa la *Bergera*, ma da questa differirne per avere le foglie semplici, mentre che quella le ha impari pennate. Esser poi ben distinta in grazia del suo ovario biloculare dalla *Limonie*, le quali lo hanno uniloculare." BROWN, ROBT., in Atti della terza rinuione degli scienzati ital., p. 533. 1841.

cluded this plant in his *Flora Hongkongensis* under the name *Atalantia buxifolia* Oliv. MS., and in the same year Oliver himself described it in his treatise on the Aurantiaceae. In his paper he doubts the Indian station for this plant, saying [Introd. p. 11]: "*Atalantia buxifolia* I believe to be an Eastern Asiatic species only, and not a Coromandel plant, as stated in Roxburgh's 'Flora Indica,'" and [p. 26] "I consider this alleged Indian station to have originated in some garden mistake . . ."

Roemer,[5] the indefatigable but uncritical compiler, described the plant in 1846 under three different names: (1) *Atalantia Loureiriana*, based on the *Limonia monophylla* of Loureiro, not of Linnaeus; (2) *Helie atalantioides*, based on *Sclerostylis atalantioides* W. & A., and having *Limonia bilocularis* Roxb. as a synonym; and (3) *Citrus buxifolia* Poir. Under the latter name, he remarks that this may be a variety of *Citrus sinensis* Risso.

The best and fullest account of the plant as yet published, giving both the morphological and anatomical characters, is that by Penzig.[6] As it was the only species of *Atalantia* studied by him, he did not have opportunity to note how widely it differs from the typical species, *Atalantia monophylla* (Roxb.) DC., and its congeners.

As a matter of fact it is very unlike the true Atalantias, differing in having a berry-like fruit becoming very dark red or nearly black, as it ripens, through the softening and darkening of the ovarial walls. The pulp vesicles remain very rudimentary, mere blunt papillae lining the ovary walls, quite unlike the pulp vesicles of the true Atalantias. Two or three large oil glands develop in the mesocarpic tissues of the young ovary.

The leaves are shiny above, very strongly veined below and emarginate (see fig. 1). The flowers are smal and the stamens are free, with rather broad filaments. The seeds are green, large and subglobose, with thin teguments, and germinate from buried cotyledons; the first post-cotyledonary leaves are cataphylls, as in *Eremocitrus* and *Poncirus* (see fig. 2).

[5] Roemer, M. J. Fam. Nat. Reg. Veg. Syn. Monogr., Fasc. 1, p. 37, 42, 52. 1846.

[6] Penzig, Otto. *Studi bot. sugli agrumi*, in Annal. di. Agric. 1887, no. 116, p. 149–163; Atlas, pl. 11, figs. 6–17, pl. 12, figs. 1–21. 1887.

The fruit characters are so different that the plant cannot be considered to be a congener of *Atalantia* and must be considered to be a distinct genus, for which the oldest available name is *Severinia* of Tenore. The oldest name for this plant becomes, therefore, *Severinia buxifolia*, with the following synonyms:

Severinia buxifolia (Poir.) Tenore, Ind. Sem. Hort. Bot. Neapol., 1840, p. 3 (?) [not seen]; Atti della terza riunione degli scienzati ital., 501–3. 1841.

(?) *Buxoides aculeata* Osb. Dagbok Ostindisk Resa, p. 242. 1757 [nom. subnud.].

Limonia monophylla Lour. Fl. Cochin. **1**: 271. 1790. [err. det.]

Citrus buxifolia Poir. in Lam. Encycl. **4**: 580. 1798.(?)

Limonia bilocularis R. Hort. Bengal. 32. 1814. [nom. nud.]

(?) *Limonia retusa* Don. Prod. Fl. Nepal. 224. 1825.

(?) *Limonia microphylla* Voigt, Syll. Pl. Ratisb. 53. 1828.

Citrus emarginata Desf. Cat. Hort. Paris, ed. 3, 235, 406. 1829.

Atalantia? bilocularis Wall. Cat. no. 6356. 1831. [nom. nud.]

Limonia bilocularis Roxb. Fl. Indica, **2**: 377. 1832.

Sclerostylis atalantioides Wight & Arn. Prodr. **1**: 93. 1834.

Atalantia Loureiriana Roem. Syn. Hesperid. 37. 1846.

Helie atalantioides Roem. Syn. Hesperid. 42. 1846.

Sclerostylis buxifolia Benth. in Hook. Journ. Bot. **3**: 326. 1851.

Atalantia buxifolia Oliv. Proc. Linn. Soc. **5**, Suppl. 2: 26. 1861 (ex Benth. Fl. Hongkong. 51. 1861).

ILLUSTRATIONS: Seeman, Bot. Voy. Herald, pl. 81, 1852–7; Penzig, O., Studi bot. sugli agrumi, Atlas, pl. 11, figs. 6–17, pl. 12, figs. 1–21, 1887.

TYPE LOCALITY: "Cette plante est originaire de la chine, & y a eté observé par Sonnerat" [in the vicinity of Canton, China].

DISTRIBUTION: Southern China (Hongkong, Kwangtung, Hainan), Tonkin, Annam, Formosa.

The writer examined in 1911 the type specimen in Lamarck's herbarium in the Muséum d'histoire Naturelle at Paris. It consists of a single leafy twig about 20 cm. long with three short branches. The branch still bears a few flower buds. There can be no possible doubt of its being the plant common in southern China. The original label in Lamarck's handwriting reads: "Citrus—de la chine." A later label in Poiret's handwriting reads: "*Citrus buxifolia*, Dict. No. —."

In the Kew herbarium is a flowering branch of *Severinia buxifolia* collected by Tenore in the botanic garden at Naples and probably a merotype of the plant upon which the genus *Severinia* was based. This specimen is undoubtedly congeneric and doubtless conspecific with the type specimen of *Citrus buxifolia* Poir.

In the Rijks Herbarium at Leyden there is an apparently authentic specimen of *Citrus emarginata* Desf., possibly a merotype, which is undoubtedly *Severinia buxifolia*.

RELATIONSHIPS

Severinia, in spite of its being referred to *Atalantia* by all recent botanical writers, is not at all closely related to the typical species of that genus. In its fruit characters it resembles *Triphasia*, but it has very different flowers, leaves, and twigs. Possibly *Severinia* may prove to be related to the aberrant Atalantias, *A. disticha* (Bl.) Merr., *A. linearis* (Bl.) Merr., *A. maritima* Merr., etc. Its affinities are certainly with *Triphasia* and other members of the tribe Citreae, rather than with *Claucena* or *Micromelum*. It is, however, distinctly not one of the true citrous fruits constituting the subtribe *Citrinae*,—*Citrus*, *Fortunella*, *Microcitrus*, *Eremocitrus*, *Poncirus*, and *Citropsis*.

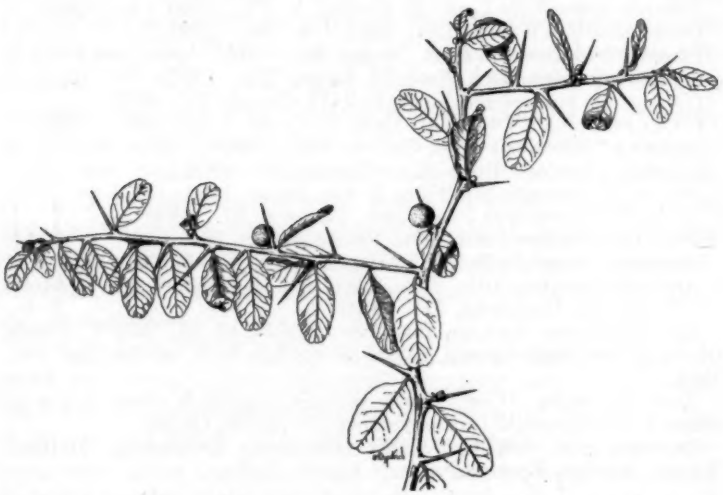

Fig. 1. *Severinia buxifolia*. Twig bearing flowers and fruits, and showing emarginate leaves and sharp spines. Scale ½.

USES OF SEVERINIA

The Severinia is a handsome shrub, readily propagated from cuttings and suitable for hedges, if care be taken to select for multiplication the very thorny forms which are common in this species. Some forms have sharp spines two to three inches long. *Severinia* has proved useful in Louisiana for hedges.

Fig. 2. *Severinia buxifolia*. Seedling, showing the cataphylls succeeded by foliage leaves. The scar of one of the cotyledons shows near the base. Natural size.

Experiments have shown that *Severinia* can withstand unusually large amounts of salt in the soil. It may prove of interest as a stock for citrous fruits in regions having alkali in the soil or having salty irrigation water.

BOTANY.—*Moreh oak, a new name for* Quercus morehus *Kellogg.*[1] W. H. LAMB, Forest Service.

The name Moreh oak is proposed as a standard common name for *Quercus morehus* Kellogg, a tree of the Sierra Nevada foothills and the north coast ranges of California.

The tree is one which has presented many problems to the botanist. It is most frequently regarded as a form of hybrid origin, one parent being the California black oak (*Quercus californica* or *Quercus kelloggii*), the other the canyon live oak (*Quercus wislizenii*).[2] The discoverer, Dr. Albert Kellogg, called the tree Abram's oak, giving it at the same time the scientific name of *Quercus morehus*. For many years, however, the meaning and derivation of the scientific name and the significance of the common name were matters of much futile speculation among botanists, and although the species was described

[1] Published with the permission of the Secretary of Agriculture.

[2] GREENE, E. L. Illustrations of West American oaks from drawings by the late Albert Kellogg, M.D., pl. 2. 1889. SARGENT, C. S. Manual of the trees of North America, p. 255. 1905. JEPSON, W. L., *Silva of California*. Memoirs of the University of California, 2: 46–49. 1910.

in 1863[3] it was not until 1887[4] that the derivations of the names were fully understood. It was the custom of Dr. Kellogg to express his veneration for Biblical characters and places by naming his botanical discoveries in their honor, just as other writers have sought to commemorate the name of friends or localities intimately associated with their experiences. In this instance it was desired by the author to recall the dwelling place of Abram, by honoring the newly discovered tree with its name. Anticipating perhaps that Moreh might not be recognized as the inspiration of his name, he called the tree "Abram's oak." But notwithstanding his precaution, the name "morehus oak" has appeared in forestry literature as the common name of this interesting tree.[5] This name has no meaning, is grammatically incorrect, and only perpetuates the fact that Dr. Kellogg's name has not been understood. The name "Abram's oak" is sometimes used;[6] but on account of the fact that the erroneous name "morehus oak" has been so widely circulated, it seems advisable to replace it with the correct English equivalent of the scientific name. It is proposed, therefore, that *Quercus morehus* Kellogg be uniformly designated as Moreh oak.

CERAMICS.—*The constitution and microstructure of porcelain.*[1] A. A. KLEIN, Bureau of Standards. (Communicated by S. W. Stratton.)

A petrographic microscopical study of porcelains prepared in the laboratory of the Bureau of Standards, of commercial porcelain, as well as of various combinations of the raw materials which enter into porcelain, has led to results which are interesting and important both scientifically and technically.

Bodies and mixtures of the following types were examined: kaolin, feldspar-kaolin, feldspar-quartz, and feldspar-clay-quartz.

[3] Proceedings of the California Academy of Science, **2**: 36. 1863.

[4] GREENE, E. L. *Biographical notice of Dr. Albert Kellogg.* Pittonia, **1**: 145. 1887.

[5] SUDWORTH, G. B. *Nomenclature of the arborescent flora of the United States.* Bull. 14, U. S. Department of Agriculture, Division of Forestry. 1897.

[6] BRITTON, N. L. North American Trees, p. 308. 1908.

[1] To appear in detail as Bureau of Standards Technologic Paper No. 80.

These were burned at various known temperatures. The commercial bodies investigated represented the practices of the following countries: United States, England, Germany, France, Austria, Denmark, and Japan. The end in view was to obtain data concerning the changes involved by burning porcelain at various temperatures; for bodies whose composition lay within the limits of whiteware and hard fired porcelains it was found possible to correlate to a certain degree the constitution and microstructure with the burning temperature.

The result of this investigation leads to the following conclusions: Kaolin appears homogeneous microscopically when heated up to 1200°. At about this temperature a trace of dissociation occurs. As the temperature is raised above 1200° the dissociation increases very slowly at first, then at an increasing rate until at 1400° it seems to be complete. The products of dissociation are silica and aluminium silicate. The latter compound has been identified as an amorphous phase of sillimanite from the following facts: it shows no crystalline form, has an index of refraction above 1.60, and by heating at a higher temperature (about 1450°) it inverts to minute needle crystallites corresponding to sillimanite in all determinable optical properties.

Up to 1340°, in mixtures of quartz and feldspar, the quartz dissolves to only a small extent in the feldspar glass. At 1460° the quartz is practically completely dissolved in specimens having as high a quartz content as 50 per cent quartz to 50 per cent feldspar.

In specimens containing kaolin and feldspar the kaolin dissociates entirely at 1340°. The amount of crystallized and amorphous sillimanite increases with an increased content of kaolin, at least to a concentration of 50 per cent kaolin to 50 per cent feldspar.

At 1460°, apparently 10 per cent kaolin is entirely soluble in the feldspar glass. With higher concentrations of kaolin the amount of crystallized sillimanite increases. The needle crystals are well developed and comparatively large.

At 1310°, in quartz-clay-feldspar bodies, the feldspar is present as a glass; the clay shows almost complete dissociation with the

formation of amorphous sillimanite mainly and but little crystallized sillimanite, while the quartz is undissolved and the grains may still be of considerable size, up to 0.2 mm. or more, depending upon the fineness of grinding.

By burning these bodies at 1380° to 1400° the feldspar glass dissolves considerable quartz, there being only a comparatively small amount of residual quartz remaining. The quartz grains are much rounded and etched and they seldom show a length over 0.06 mm. The clay is dissociated with the formation of crystallized sillimanite, although an extremely small amount of amorphous sillimanite may be present.

The changes involved by burning commercial bodies are identical with those of laboratory prepared bodies. The quartz grains observed in whiteware and in low-fired vitreous ware are large and angular, showing a size of 0.2 mm., or more, whereas in the hard porcelains, due to solution, the quartz grains are rounded and etched, and seldom exceed 0.05 mm. in length.

The constitution and the microstructure of porcelain depend upon the temperature of burning, and change as this temperature changes. This has served as a basis for the estimation of the probable burning temperatures of the commercial bodies, a fact which was accomplished with success, the error involved being within 25°. It appears that the time-of-burning factor is by no means as important as that of the burning temperature in determining the constitution and microstructure of the ware.

No cristobalite or tridymite has been definitely observed in any of the laboratory or commercial bodies examined. It appears that the quartz dissolves in the feldspar glass more readily than it inverts to the other modifications of silica.

In conclusion, it may be stated that the petrographic microscopic study of porcelain has led to interesting and, it is to be hoped, important technical results. It has placed the chemical and physical processes involved in the formation of porcelain on a more quantitative thermal basis. Furthermore it has offered a means of estimating the burning temperature of a ware by an examination of a fragment much too small in size to be satisfactory for even a chemical analysis.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

TERRESTRIAL MAGNETISM.—*On the results of some magnetic observations during the solar eclipse of August 21, 1914.* L. A. BAUER and H. W. FISK. Journ. Terr. Mag., **21**: 57–86. 1916.

In response to a circular letter issued by the Director of the Department of Terrestrial Magnetism, several observatories made observations during the eclipse of August 21, 1914, and forwarded their data to Washington. The present paper comprises a compilation of abstracts of the reports of the various institutions which supplied data, and a discussion of the results.

At the four stations, Eskdalemuir, Stonyhurst, Kew, and Rude Skov, the maximum phase of the eclipse occurred at about the time when the declination needle was approaching its maximum westerly position for the day, and on examining the curves for these stations it appeared that at each one of them a bay occurred a few minutes before the time of maximum obscuration. As the result of this bay the customary progression towards a westerly extreme was interrupted, and a retrograde movement occurred, which continued for some time. Of the above stations, the bay was most developed at Rude Skov, the nearest one of the four to the belt of totality.

On plotting a vector diagram for Rude Skov, with the north and west components of the field as derived from the observed declinations and horizontal intensities, it was found that during the eclipse the regular course of the curve was interrupted and a loop was described. The occurrence of this loop, which appeared also in the vector diagrams for Eskdalemuir and Kew, is in harmony with the similar effect found at Rocky Mount, North Carolina, during the total eclipse of May 28, 1900.

Atmospheric-electric observations were furnished by Kew, Eskdalemuir, and the Department of Terrestrial Magnetism. The conduc-

tivity gave no reliable evidence of any effect attributable to the eclipse, and, while the diurnal variation curves for the potential-gradient showed depressions at the time of maximum obscuration, this effect was not sufficiently pronounced, in relation to other variations, to render its connection with the eclipse a certainty. W. F. G. S.

GEOLOGY.—*Notes on some mining districts in eastern Nevada.* JAMES M. HILL. U. S. Geological Survey Bulletin 648. Pp. 207, with 6 plates and 18 figures. 1916.

This reconnaissance report describes 29 mining districts in eastern Nevada, extending from the line of the Southern Pacific Railroad to the Colorado River and comprising parts of Elko, White Pine, Lincoln, Nye, Clark, and Lander counties. Details of the mining development in the various camps are given, as well as information concerning the production of those districts for which figures are available. The report discusses briefly the grouping of the copper, lead, gold, and silver deposits about or near masses of granitic rocks which are intrusive into Paleozoic sediments ranging in age from Cambrian to Permian, and of gold veins in the probably pre-Cambrian schists near the Colorado River. It includes notes on the tungsten deposits in the Kern Mountains of northeastern White Pine County, and on gold deposits associated with Tertiary volcanic rocks at Atlanta, Lincoln County, in which carnotite is found. Most of the deposits discussed are either replacements or veins. Contact metamorphic deposits, though of some importance, are not as common in this region as would be expected from the wide distribution of intrusive rocks. J. M. H.

GEOLOGY.—*Geology and ground waters of northeastern Arkansas, with a discussion of the chemical character of the waters.* L. W. STEPHENSON, A. F. CRIDER, and R. B. DOLE. U. S. Geological Survey Water-Supply Paper 399. Pp. 315, with 11 plates and 4 figures. 1916.

The report describes the physiography, geology, and ground water resources of that part of Arkansas lying northeast of Arkansas River and east of the Ozark hills. Much information compiled from scattered previously published sources is incorporated, together with a large amount of new data gathered by the authors in the field and by correspondence. Emphasis is laid on the availability of the vast quantities of water contained in the Pleistocene alluvial deposits for the irrigation of the extensive tracts of land that are suitable for rice culture.

The section on geologic history describes the interesting succession of events that resulted in the formation of the alluvial lowlands composing the greater part of the area treated. The chapter of the chemistry of the waters contains in addition to the discussion of the character of the Arkansas ground waters, much general information on the mineral constituents of water, the character of water suitable for boiler use, irrigation, and domestic use, and methods of purifying water.

L. W. S.

GEOLOGY.—*The Pliocene Citronelle formation of the Gulf coastal plain and its flora.* GEORGE CHARLTON MATSON and EDWARD WILBER BERRY. U. S. Geological Survey Professional Paper 98-L. Pp. 167–208, with 16 plates and 3 figures. 1916.

This report describes the character and areal distribution of the Pliocene deposits, chiefly non-marine, occurring near the seaward margin of the Gulf coastal plain from Florida to eastern Texas. These are called the Citronelle formation, which is made to include portions of the deposits formerly classified as "drift," "Orange sand," "Lafayette," and "Grand Gulf." The fossil plants, by means of which the age determinations are made, are represented by 18 species. Three of these are Pleistocene and Recent forms and 15 are extinct, the latter embracing 2 West Indian and one non-American type. The plants are, without exception, coastal forms and they indicate climatic conditions very similar to those prevailing at the present time along the Gulf coast, and a physiography of barrier beaches and coastal lagoons, with gum swamps and cypress ponds near the coast. It is concluded that this flora flourished in the latter half of the Pliocene. E. W. B.

GEOLOGY.—*The Lower Eocene floras of southeastern North America.* EDWARD WILBER BERRY. U. S. Geological Survey Professional Paper 91. Pp. 481, with 117 plates and 16 figures. 1916.

This report describes a small flora of early Eocene age from Texas, tentatively referred to the Midway formation, and gives an exhaustive discussion of the large flora of the Wilcox Group. The character, succession, areal distribution, and stratigraphic relations of the Wilcox deposits are described, and it is shown that the Wilcox is separated by a hitherto unrecognized time interval from the underlying basal Eocene, or Midway, and from the overlying middle Eocene, or Claiborne.

The Wilcox flora, which comprises over 300 species, is fully described and figured, and its composition, distribution, relations, and environ-

ment are discussed in great detail. The Wilcox flora is one of the most extensive American fossil floras known from a single horizon in a single area, and it includes a large number of types hitherto unknown from North America and more than 200 species new to science. It contains large numbers of figs, lauraceae, and leguminosae and is prevailingly a strand flora, subtropical in character, which invaded southeastern North America from the equatorial region at a time when the Mississippi Gulf reached northward to southern Illinois and covered nearly all of the states of Mississippi and Louisiana as well as a large area in Alabama, Tennessee, Arkansas, and Texas. The Wilcox deposits are definitely correlated with the Sparnacian and Ypresian stages of the European lower Eocene section. E. W. B.

GEOLOGY.—*The Catahoula sandstone and its flora.* GEORGE CHARLTON MATSON and EDWARD WILBER BERRY. U. S. Geological Survey Professional Paper 98-M. Pp. 209–259, with 13 plates and 7 figures. 1916.

The Catahoula sandstone is redefined and its lithology, topography, structure, thickness, origin, and stratigraphy are discussed. It is shown that in central Louisiana this formation is interbedded with lower Oligocene limestones and marls of the Vicksburg formation, while near the Texas line it replaces all of the marine lower Oligocene. Across Mississippi the Catahoula lies above the Vicksburg, and eastward in Alabama and western Florida it merges into the marine beds of the Chattahoochee formation.

TECHNOLOGY.—*The density and thermal expansion of American petroleum oils.* H. W. BEARCE and E. L. PEFFER. Bureau of Standards Technologic Paper No. 77. Pp. 26. 1916.

This paper gives an account of the experimental work on which are based the expansion tables of Bureau of Standards Circular No. 57, *United States standard tables for petroleum oils.* It gives a detailed description of the methods and apparatus employed in the determination of the density and thermal expansion of petroleum oils from the various oil fields of the United States. H. W. B.

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